regarded by military men as an important means of reconnoitring. The Paris photographer and aëronaut, Nadar, was successful on several occasions in securing photographic records from balloons, but he never published his *modus operandi*; and the problem of balloon photography is one which still excites a good deal of attention. Mr. Walter Woodbury, the well-known inventor of Woodburytype—the only practical photo-engraving process we know—submitted, during the last war, to the Russian government, a very ingenious method of securing pictures at an altitude. By his plan no one ascends with the balloon at all, and therefore the latter may be of very limited dimensions. It is captive, and twisted into the tethering rope are insulated wires in connection with a camera. The camera is weighted and hung upon a pivot so as to be always horizontal, and a fan attached to the balloon prevents the same from gyrating. It is easy to understand how a lens may be capped and uncapped from below with the aid of an electric current, and the photographs are secured—for a series may be taken at one ascent—upon a length of sensitive tissue which is unrolled for use through the medium of clockwork. The sensitive tissue and roller arrangement is that of M. Warnerke, which is known to all dry plate workers, and which permits of securing pictures without glass. Mr. Woodbury's invention has, so far, been tested only in respect to its photographic properties, but in cases where an aëronaut would run too much risk, or where a large supply of gas is not available, the apparatus would be well worthy of trial.

It is the difficulty of securing a sufficiency of gas for inflation that at present stands in the way of employing balloons in the field. The French balloons are all large ones, for they were constructed most of them for postal service during the siege, and, besides the mails and aëronaut, sometimes carried three passengers. With the exception of half-a-dozen, all the balloons which left Paris had a uniform capacity of 2,000 cubic metres, while one, in which M. de Fonvielle and three other persons travelled from Paris to Louvain, measured 3,000 metres. Such bulky balloons as these are unsuited for the field, where the problem is to send a single observer aloft with the minimum amount of time and trouble. The smallest balloon and the lightest gas for the purpose are what the soldier seems to require, and it is towards these two points that attention has lately been directed by Capt. Templar and the other officers who are just now occupied in the study of aërial navigation in this country. Naturally enough, hydrogen holds out the most promising features as a lifting medium, and it is with this gas that experiments are once more to be made. As our readers remember, the weight of hydrogen is calculated to be 2·14 grains per 100 cubic inches, while air on the other hand weighs 31 grains; and, as the lifting power is represented by the difference between these numbers, it stands to reason that theoretically, a balloon, if filled with hydrogen, need be of but comparatively very small dimensions. Unfortunately, in a practical affair like ballooning, a lot of accidental matters require to be taken into consideration, and two of these are the facts that it is difficult to secure pure hydrogen, and more difficult still to keep it in the balloon envelope when secured. Capt. Templar is sanguine that a 10,000 cubic feet balloon is quite capable of lifting an observer high enough for reconnoitring purposes, if filled with hydrogen, and well-nigh proved his case the other day when he overcame gravity, if he did not rise, with the aid of a light coal-gas with which this small balloon was filled. The coal-gas, specially manufactured for his balloon, had a lifting-power of 50 lb. per 1,000 feet, so that a total of 500 lb. was here at his disposal. As we have said, this was insufficient for an ascent, for, besides the weight of the aëronaut, there are, it must be remembered, envelope, car, tackle, cable, and ballast to be taken into consideration. Instead of 500 lb., hydrogen of the same volume would have supplied a lifting-power of 700 lb., and this of course would have been ample, and to spare, for an ascent.

To make this hydrogen recourse will be had, as in previous experiments undertaken by our military authorities, to the decomposition of water in the form of steam. The latter is to be passed through tubes filled with iron filings or turnings, and these, in becoming oxidised, set free the hydrogen. Unfortunately the hydrogen obtained in this way is impregnated with moisture, and unless submitted to the action of some desiccating agent like quicklime, for instance, is of little good for ballooning. The hydrogen it is proposed to obtain in the field, at any rate, in this fashion, and it remains to be proved whether Capt. Templar and his colleagues can secure it sufficiently pure and in proper quantity under these practical conditions. Although hydrogen is given off fast enough at the outset, previous experimenters have found the supply to fall off rapidly, for as soon as the surface of the particles becomes oxidised the decomposition of the steam ceases.

But perhaps the most interesting feature of the present ballooning experiment will be the trial of compressed gas. As our readers know very well, compressed gases are now a commercial article in this country, and you may purchase cylinders of oxygen or hydrogen at twenty atmospheres pressure. As our Royal Engineers carry about with them in the field such unwieldy things as pontoons, they can hardly grumble at a waggon load of hydrogen tubes, and with these it is suggested to fill a balloon just wherever a reconnaissance is to be made. On nearing the enemy the first convenient spot will be chosen for the manufacture of the hydrogen, and this will then be compressed, with the assistance of suitable apparatus, into the tubes, to be drawn off again when the ascent is to be made. In this way there is always to be gas at hand not only to fill the balloon but to keep up a constant supply for a limited period, since hydrogen, under the most favourable circumstances, rapidly exudes from a balloon envelope.

A military balloon, it appears to be decided, must be a captive one, and opportunity would of course be taken to place the observer in electrical communication with the earth through the medium of insulated wires twisted round the rope in the same way as in Mr. Woodbury's photo-aërial apparatus above described.

H. BADEN PRITCHARD

HYPNOTISM

THE phenomena of "hypnotism," "mesmerism," or "electro-biology," have of late years excited so much popular interest—not to say popular superstition—that their investigation by a competent man of science will appeal to the sympathies of a wider public than the purely scientific. My object, therefore, in writing the present article is to give a brief review of a monograph on this subject, which has just been published by the well-known physiologist, W. Preyer of Jena.[1]

In order to eliminate all possible effects of the imagination, Preyer performed his experiments only upon animals, and he begins his paper with an historical sketch of previous investigations of a similarly restricted nature. First we have the "Experimentum mirabile" of the Jesuit Athanasius Kircher, published by him in the year 1646.[2] This consists in taking a common fowl, binding its feet together, and placing it on a floor. As soon as it has ceased to struggle a straight line of chalk is drawn from the point of its bill along the floor. If the legs are now

[1] Die Kataplexie und der thierische Hypnotismus. (Gustave Fischer, Jena, 1878.)

[2] In a postscript Preyer states that he has found this experiment to have been published ten years earlier, by Daniel Schwenter, and the quotation which he makes from Schwenter's book goes to prove that Kircher probably derived his knowledge of the experiment from that source.

untied the fowl makes no endeavour to escape, but remains as it were transfixed, and refuses to move even when urged to do so. Preyer observes in passing that the chalk line constitutes no essential part of the conditions, inasmuch as a fowl may be equally well thrown into a state of hypnotism by simply holding the animal for a short time upon the ground so as forcibly to prevent struggling.

After Kircher no one seems to have investigated the phenomena of hypnotism, or, as Preyer calls it, kataplexy, till the years 1872-73, when some articles on the subject were published by Czermak. The most striking of his experiments were those which he conducted on invertebrated animals—crayfish, for instance, being made to lie on their backs motionless, or even to stand upright upon their heads. Czermak endeavoured to account for the facts which he described by supposing that in some way or other the act of fixing the eyes upon a certain object, or of gazing into space, caused the animals to become sleepy and stupefied.[1] So vague an explanation could scarcely in any case be entitled to rank as a physiological hypothesis, and Preyer showed, in 1873, that the act of gazing had nothing to do with inducing the state of kataplexy, inasmuch as animals fell into exactly the same state when their optic nerves were divided, or their eyes covered with a hood—provided that their bodies were at the same time held in some unnatural position. Preyer therefore propounded a theory of his own, which, as first published, was that the state of fear into which the animal is thrown by being held in some unusual attitude serves to inhibit the power of volition and so of spontaneity—the animal, therefore, when released remaining statue-like in the position in which it was placed. In order to sustain this theory Preyer pointed to other cases in which fear serves to inhibit spontaneity—as, for instance, the motionless horror which some animals exhibit in the presence of great danger, the fascination of birds by snakes, &c. The theory as thus stated was very justly criticised by Heubel, who, in 1876, published a paper detailing his own researches on the subject, and seeking to identify the state of hypnotism with that of ordinary sleep. The effect of this criticism was to make Preyer state his theory with greater clearness, and as we now have it (1878), it seems to be as follows. Any "sudden, strong, unexpected, and unusual stimulation of centripetal nerves" produces an emotion of fear, which in turn produces some inhibitory effect on the will, and eventually a state of stupor. It may, I think, still be questioned whether this theory is of very much value, for even granting that "deathly terror" is always present—which it certainly need not be when the subject of the experiment is a human being—we are not acquainted with any other facts which would lead us to connect the subsequent state of motionless stupor with the preceding state of active fear.[2] But, passing on to the facts, we soon find that an important exception must be taken to the above statement as to the conditions under which hypnotism occurs, for various experiments proved that "sudden, strong, unexpected, and unusual stimulation" of any of those "centripetal nerves" which minister to the *special senses*, so far from inducing a state of hypnotism, instantly aroused an animal which had been previously thrown into that state. So that, in point of fact, as we are afterwards told, we may more correctly state the conditions which produce kataplexy in animals, by substituting for the words "centripetal nerves" in the above-quoted proposition, the words "nerves of tactile sensation." But here I may observe that, so far as the experiments go, there is nothing to prove that special stimulation of even the cutaneous nerves is necessary (indeed thermal and chemical stimulation of the skin was specially tried and produced no results); and therefore, it seems to me, the possibility is not excluded that the special stimulus in question may really have reference only to the "muscular sense." At any rate, all these experiments go to prove that kataplexy can only be produced in animals, either by suspending them in the air, or by forcibly holding them in some unusual position. Most animals recover their normal state after a few minutes, but frogs when suspended in the air will continue kataplectic until they die. Horses become kataplectic while they are being swung from wharves to ships, as shown by the fact that they remain passive so long as they are suspended in the air, but again begin to struggle so soon as their feet touch the deck. Preyer has succeeded in rendering kataplectic various species of toads, newts, frogs, ducks, poultry, pea-fowl, partridge, sparrows, mice, guinea-pigs, rabbits, &c.; but has uniformly failed in the case of many other animals. On the whole he concludes that while among sundry species of reptiles,[1] batrachians, birds, rodents, and ruminants, the phenomena of kataplexy may be more or less easily produced, such is not the case with fish and the more intelligent mammals. Nevertheless in another part of his memoir he attributes to a state of partial kataplexy the period of motionless delay which is observable in children after they unexpectedly fall and before they begin to cry. He also states, on the authority of Dr. Genzmer, that a squalling child (not a young baby) may often be quieted by laying it upon its stomach, or by gently pressing its face with the hand—care being taken in neither case to interfere with the breathing.

Our author further maintains that the so-called "shamming-dead" of certain species of *Articulata* when in the presence of danger is probably to be attributed to kataplexy. But here, I think, it is difficult to agree with him. That the action in question is not a properly so-called *intelligent* one, no competent person at the present day is likely to dispute; but for my own part I cannot see any evidence to show that it is not of the nature of an instinctive action which has been developed in the way to which Preyer alludes. It being for the benefit of some animals that they should remain motionless, and thus be comparatively inconspicuous in the presence of danger, those individuals which endeavoured to escape would be destroyed, while those which ceased to move would survive. Natural selection would therefore soon fix the artifice of "shamming-dead" as an inherited instinct. To this view Preyer objects that, if we accept it, the *origin* of the instinct is difficult to explain; while on the supposition of the action not being instinctive, but purely kataplectic, there is no difficulty to surmount. But to this it may be answered that there is no more difficulty in explaining the origin of the instinct to remain passive in the presence of danger than there is in explaining the

[1] When we fix our eyes upon a certain object and then alter their adjustment for some more distant point, so that the eyes endeavour, as it were, to look through the object, there is no doubt that after a time a somewhat sleepy feeling may be produced. Some persons, I find, can perform this action more easily than others, and it does not seem to consist altogether in maladjustment. At least I have observed that when the action is performed by persons who can do it well the pupils dilate prodigiously, and this even when the eyes are fixed upon a bright light such as the naked flame of a moderator lamp. As the action is completely under the control of the will, one is thus able to observe the curious spectacle of the inhibition by the will of a reflex which under all other circumstances is beyond the control of the will—the pupils dilating or contracting instantly at word of command, and quite irrespective of the stimulus supplied by light.

[2] Indeed a very remarkable experiment which is detailed further on would seem to show that even in the case of animals the state of fear need have nothing to do with inaugurating the state of kataplexy. The experiment in question consisted in suddenly decapitating a fowl, and while the reflex convulsions were still in progress, holding the mutilated body firmly on its back. The convulsions forthwith ceased, and the headless animal became for a time kataplectic. Unless, therefore, we suppose that the spinal cord is capable of suffering fear, and that it is more alarmed by being held firmly down than by being severed from the brain, we must conclude that a state of fear is no essential antecedent to that of hypnotism.

[1] Preyer does not appear to have himself experimented on any species of reptile, but in another part of his monograph refers in this connection to a very old authority, viz., Moses, whose power of causing serpents to appear like rods he supposes to have been probably due to the sagacious Israelite having known something about the phenomena of kataplexy. But considering the number, variety, and general quality of the experiments which Moses is said to have performed, it would surely be desirable to repeat the one in question before accepting the result as a fact of modern physiology.

origin of any other instinct—that of running away from danger included. Moreover, one of the animals to which Preyer refers, viz., the *Armadillo vulgaris*, not only remains motionless when alarmed, but rolls itself up into a ball—an action which certainly cannot be explained on the hypothesis of kataplexy. The most, therefore, that can be said for this hypothesis is, that possibly in its first initiation the instinct may have been assisted by the occurrence of kataplexy.

The time during which the kataplectic stupor lasts varies in different species of animals, and also in different individuals of the same species. The maximum duration observed in the case of rabbits was twelve minutes; but fowls and guinea-pigs continue stupefied for a somewhat longer time. By watching carefully for the first indications of recovery, and by preventing the voluntary movements in which these indications consist, animals may be kept in a state of kataplexy for an indefinite time. Warm-blooded animals do not suffer from such prolonged experiments; but the latter are fatal to frogs. In mammals the most characteristic features of the kataplectic state, besides that of unconscious stupor, are violent tremblings of the extremities, blinking of the eyes, movements of the jaw and pupils, irregularity of the pulse and breathing, pallor of ears in rabbits, occurrence of defæcation and micturition. On recovery the abnormal state passes off suddenly, leaving the animal bright and brisk as before, and thus, as in so many other respects, the state of kataplexy differs from that of ordinary sleep.

One other point of interest must be noted. Preyer finds that it is impossible to produce the state of kataplexy in any animal that is "newly-born." In the case of guinea-pigs susceptibility to be thrown into this state only begins to show itself during the first week after birth, and then gradually increases through two or three weeks. This curious fact is explained by the hypothesis that the volitional centres—or the centres which are supposed to be affected by kataplexy—require some time after birth to be brought into functional relation with the lower centres.

On the whole, then, it will be seen the facts relating to the hypnotism of animals are much more definite than the theories by which it is sought to explain them; and although we may be prepared to agree with Preyer that these facts in some way depend on certain unusual stimuli acting in some peculiar manner on some inhibitory centre or centres, we must feel that this statement of the case brings us only to the threshold of an explanation.

GEORGE J. ROMANES

HYDROGEOLOGICAL SURVEY OF ENGLAND

FLOODS, or water in excess above ground, form one of two extreme conditions, of which the other is drought, or water in defect below as well as above ground. The requirements of water-supply induce the necessity for storage. Out of these three simple facts arise several intricate public questions. Thus it is evident that, if floods are to be controlled, some one must have authority over the rivers, and inasmuch as floods are intensified by land drainage, that authority must extend over the whole of the watershed area if it is to execute measures of a sufficiently comprehensive character to be effective. As works cannot be constructed without money, it must also have rating powers over the whole river basin for the purpose of raising the necessary funds to cover the cost of such remedial works. But inasmuch as the flooded lands bear a small proportion to the contributary area, that is, to the rest of the watershed basin, the consequent preponderance of influence and capital is largely in favour of the unflooded portions. Therefore, if the case of floods rested for its remedy solely upon the loss sustained by riparian owners, it is doubtful whether the British public would ever be brought to see the desirability of moving in the matter. Drought, however, is felt by an increasing population, whose interest in having a proper water-supply is as deep as can be desired. The public looks to the engineer to provide proper storage, who is thus called upon to unravel at least two of the knots that surround the subject of rivers considered in relation to the storage of water. The first of these is of a purely physical kind, and is simply this: that whereas water for the purposes of water-supply is required at high levels, the pure rain which falls upon the declivities of the watershed area at once proceeds to find the lowest level or the deepest ruck in the valley, down which it courses, along the natural main drain of the basin, and below the level of all possible habitations, to the sea. Therefore, before it can be used, it must be lifted out of this ruck. Here steps in the second difficulty. Some one has a vested right in every yard of this water, and a real or supposed interest in obstructing every attempt to divert any portion of it. Waterworks having rivers for their sources have for these reasons proved too expensive for scattered populations in the past. Nevertheless, when fish was a necessary article of diet, the money and influence were forthcoming to cause the construction of a series of very noble ponds, and subsequently when the manufacture of iron flourished in the south of England, many more were added for the purposes of water power; while in some cases water was diverted from the main channel and carried in an open conduit, as in a mill race, with the same object in view. In the case of canals, much of the best and purest spring water the country contains has been degraded from its higher uses to the purpose of a common carrier, but now that the requirements of the population have changed, and it is no longer essential either for the one purpose or the other, but is wanted for drinking, it should be the aim of the engineer to do for water supply what has been done for water power, but on a more comprehensive and extended scale, viz., to keep the water as high as possible by diverting as much as he can take from the upper tributaries, and causing it to contour as far as possible along the ridges with a view of commanding the largest extent of country by gravitation, and to compensate the main channel by a series of storage ponds. Numerous instances may be found in the lower greensand districts in Surrey, formerly a seat of the iron trade.

As a whole, the country is more largely dependent upon subterranean sources, or upon wells, for its water supplies than it is upon rivers. Inasmuch as every well that is sunk increases by a small amount the storage capacity of the stratum, the tendency is in the direction of a gradual lowering of the water-line. The resources of the subterranean water systems cannot be taxed indefinitely. Under London an elliptical vortex has been pumped out whose dimensions below sea-level are twenty miles long, eight miles across, and 130 feet deep, the total amount of depression at the apex being about 150 feet. Yet we have very recent instances of destructive local floods in the Metropolitan area immediately above this great centre of exhaustion. These two considerations point to the multiplication of wells, coupled with a proper system of replenishment from flood waters, as a means of utilising these natural reservoirs. The restoration of the original levels under London would restore to upwards of one hundred square miles of country their lost property as Artesian areas of overflow, the value of which is such as to confer upon the surface its full value as building land.

Thus, as storage above ground is expensive, and generally in supposed conflict with the interests of rivers, few of the numerous natural sites for reservoirs in England have been utilised, except in some places in the southern counties, where they were dammed up for fish ponds and